involving the Rydberg constant. Nine bands of the main series and four of the fainter second series have been identified.

(2) The two series may be likened to the Principal and Diffuse series in the case of line spectra, but the usual relation between such series is not certainly indicated, and no equivalent of the Sharp series has yet been traced.

(3) The doublet separations are not in accordance with those associated with line spectra; they diminish in passing along the series, but do not vanish at the limit.

No regularity in the arrangement of the single bands has been recognised.

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The Influence of Molecular Constitution and Temperature on Magnetic Susceptibility. Part III.—*On the Molecular Field in Diamagnetic Substances.*

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(Abstract.)

The work is a continuation of that in 'Phil. Trans.,' A, vol. 214, pp. 109–146, which contains Parts I and II.

The suggestion made at the end of Part II, p. 143, that the local molecular field in diamagnetic crystalline substances may be comparable with the ferromagnetic molecular field, has been justified. Estimates of the order of magnitude of this field have been obtained from the following sources:—

(a) *The change of specific susceptibility accompanying crystallisation.* The extent of this change may be interpreted, on Langevin's theory of diamagnetism, as produced by a local molecular field of the order of intensity 10^7 gauss, which comes into operation on crystallisation (§ 4). This intense local field distorts the molecules and alters the periods of vibration of the contained electrons. From the nature of the structure which has been postulated for a diamagnetic molecule, this field is of an alternating character, the distance over which it is unidirectional being comparable with the

distance between the molecules. When a substance crystallises, the periods of the vibrating electrons will be changed and the extent of this change is the Zeeman effect of the local molecular field. In general we shall get a simple displacement of the line, corresponding to a particular vibration, and not a doubling. This effect is a consequence of the peculiar structure of the diamagnetic molecule and its magnitude is a measure of the shift of an absorption band owing to crystallisation. (*Cf.* the pressure-shift of spectrum lines.)

(b) *The large value of the natural double refraction of crystalline media, as compared with the artificially induced double refraction in the corresponding liquids when subjected to the largest magnetic field at our disposal.*

It is at once seen that the local molecular field must be large compared with the largest field obtainable in the laboratory ($< 10^5$ gauss) in order to account for the augmented double refraction of the crystalline state. The value of the local molecular field deduced is of the order 10^7 gauss (§ 4).

(c) *The potential energy associated with the local molecular field.* The intense local molecular field which (a) and (b) disclose implies that the potential energy (magnetic) associated with a diamagnetic crystalline structure is very large. This energy, expressed in thermal units per gramme of the substance, is a measure of the latent heat of fusion (§ 5). The values so obtained are of the right order of magnitude. If, as the fusion point is approached, the molecules assume rotational vibrations, then we should expect that the specific heat of the substance would be abnormally high over such a critical region of temperature. Abundant experimental evidence shows that such is the case.

(d) *The change of volume on crystallisation may be interpreted as a magneto-striction effect of the molecular field,* providing this field has an intensity of the order 10^7 gauss locally.

These results are sufficient to establish the magnitude of the local molecular field in crystalline diamagnetic substances and show that it is of the same order of intensity as the ferro-magnetic molecular field. As stated above, this field in diamagnetics is of an alternating character, the distance over which it is unidirectional being comparable with the distance between the molecules. Nevertheless, it produces a definite distortion in every molecule of the crystalline structure. This is in accordance with the hypothesis of molecular distortion, which forms the starting-point of the present work (see the Introduction to Part I). It is this intense mutual action between the molecules which gives rise to the rigidity of crystalline media. As the molecules will exert different mutual influences in different directions, according to their particular structure, the rigidity will be greater in some directions than in others. This accounts for the existence of planes of cleavage in crystalline media (§ 5).

The experimental evidence for the change of susceptibility on crystallisation, from which the theory of the molecular field in diamagnetic substances has developed, is contained in Part I. About 25 aromatic substances were investigated altogether, and for these the conclusions stated above hold good in so far as the data for individual cases are obtainable. Aliphatic substances, however, show an almost inappreciable change of susceptibility on crystallisation, and the object of the additional experiments of § 6, together with the "parallelism between the magnetic double refraction of liquids and the change of susceptibility due to crystallisation," developed in § 7, is to show that these conclusions may be extended to diamagnetic crystalline media in general. The extent of the induced magnetic double refraction depends upon the degree of dissymmetry and unsaturation of the molecule. As the induced double refraction in aliphatics is inappreciable (Cotton and Monton), we may conclude that these factors are small for such substances. In the most favourable cases of unsaturation and dissymmetry the value of $\partial\chi$ amounts to a few per cent. only. It is, therefore, probable that with aliphatic substances the value of $\partial\chi$ would not be detectable, even though the molecular field is comparable with 10^7 gauss.

The source of the local molecular field in diamagnetic substances must be located in the individual atoms. The molecular field is then a result of the co-operation of these atomic fields when the molecules become related to one another in a definite way in the crystalline structure. It is pointed out that such fields residing within the atoms are identical with the magnetic atom fields of Ritz and Humphreys, and probably also with the field of the magneton.

In conclusion, a discussion of the nature of the molecular field is given (§ 8). This field must be localised to a large extent in all substances in order to satisfy the condition of continuity of magnetic induction. I hope to publish further extensions of this work in a future communication.